## Radiative Forcing from the stratospheric Volcano and wildfire smoke between 2014-2022

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### Stratospheric aerosol: transport, processes, impacts



# **ASM: Smokestack to the stratosphere**



Park et al, JGR, 2009

Randel et al. Science 2010

### 14 years' measurements on Tibetan Plateau

-8

-10

0

5

10

SAD ( $\mu$ m<sup>2</sup> cm<sup>-3</sup>)

15



**CFH: H2O** Cobald: backscatter

Prof. Jianchun Bian @ IAP, Chinease Academy of Science

### **CESM-CARMA** is a sectional aerosol model

#### **CAM5/CARMA Model**



Model development refs: Yu et al., 2015 JAMES; Yu et al., 2019 GRL; Yu et al., 2022 GRL

# Sulfate, organics and nitrate are the main aerosol composition in ATAL



Yu et al. 2022

# Asian summer monsoon: efficiently transport pollutants to the global stratosphere



# In-situ measurements in the background of the background (2021-2023)





Better quantify the polutants transported to UTLS via ASM

Zhu, Yu\* et al., in preparation

### More sites during the 2<sup>nd</sup> Scientific Expedition of Tibetan Plateau (2019-2024)



Prof. Jianchun Bian @ IAP, Chinease Academy of Science

### POPS launched in Tibetan Plateau and Boulder observed the stratospheric perturbations



Yu et al., 2023, under review

# Since 2014, extreme wildfire contributes to about 10% of stratospheric aerosol anomalies



#### 2014-2022 Stratospheric aerosol's lifetime is 50% longer than that of 2005-2013



### Rapid stratospheric adjustment is important to quantify the Radiative Forcing





OC/BC absorbs solar radiation, warms the stratosphere:

More cooling at TOA due to outgoing long wave radiation; More cooling at Tropopause due to less solar radiation passed through

Liu, Yu\* et al. 2022; Yu et al., 2023; Yu et al., 2019; Yu et al. 2021

### Compared with volcanic aerosol, smoke cools the Earth more by 60%



Yu et al., 2023, under review

# Global warming rate were 20% larger without stratospheric aerosols in last two decades



### Stratospheric aerosol from 2014-2022 cooled the GMST by 0.06K, offsets a smaller fraction of the observed warming compared with 2005-2013



Yu et al., 2023, under review -

### **Summary**

- ATAL: organics, sulfate and nitrate
- Asian summer monsoon can effectively transport tracers into the stratosphere
- Long-term POPS measurements in Tibetan Plateau and Boulder are used to validate CESM-CARMA
- 2014-2022 stratospheric aerosol's lifetime is 50% longer than 2005-2013
- Wildfire organics cool the TOA with 60% more negative ERF per unit AOD
- Global warming rate were 20% larger without stratospheric injections in the last two decades

## **ASM: implementing geoengineering efficiently**



Liu, Lu, Yu\* et al. 2023, in preparation

ACAM Meeting

# **Thanks for Listening**

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